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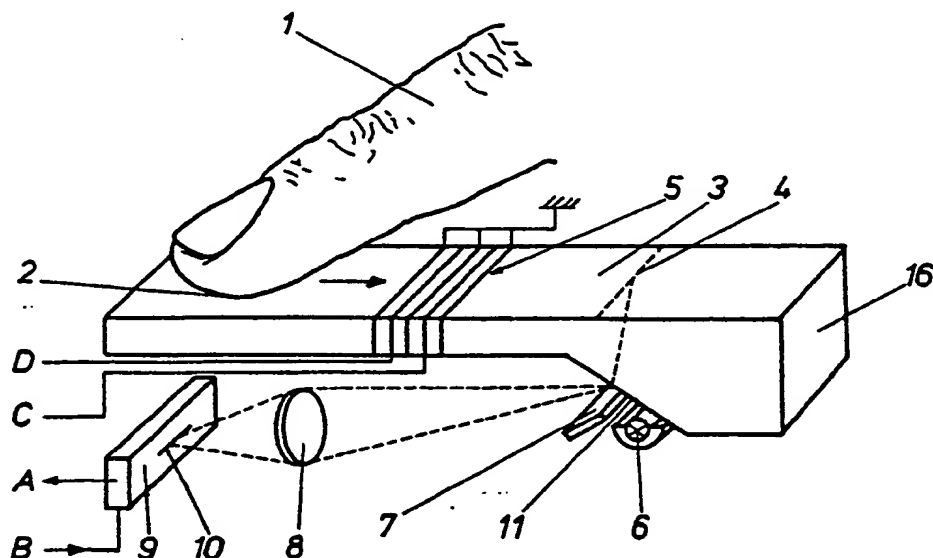
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : A61B 5/10	A1	(11) International Publication Number: WO 86/ 06266 (43) International Publication Date: 6 November 1986 (06.11.86)
<p>(21) International Application Number: PCT/DK86/00044</p> <p>(22) International Filing Date: 28 April 1986 (28.04.86)</p> <p>(31) Priority Application Number: 1984/85</p> <p>(32) Priority Date: 2 May 1985 (02.05.85)</p> <p>(33) Priority Country: DK</p> <p>(71) Applicant (for all designated States except US): JYDSK TELEFON A/S [DK/DK]; Sletvej 30, DK-8310 Århus (DK).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only) : JENSEN, Palle, Rasmus [DK/DK]; Forhåbningsholms Allé 30, DK-1904 København V (DK).</p> <p>(74) Agent: LARSEN & BIRKEHOLM A/S SKANDINAVISK PATENTBUREAU ; Niels Hemmingsens Gade 32, DK-1153 København K (DK).</p>		<p>(81) Designated States: AT, AT (European patent), AU, BE (European patent), BG, BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (Auxiliary utility model), DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.</p> <p>Published <i>With international search report.</i> <i>In English translation (filed in Danish).</i></p>

(54) Title: METHOD AND APPARATUS FOR AUTOMATIC SCANNING OF FINGERPRINTS**(57) Abstract**

An apparatus for automatic scanning of a fingerprint by optical scanning of the fingerprint side (2) of a finger (1) comprises a scanning surface (3) with a measuring means (5) for the rate of movement of the finger in relation to the scanning surface, and with a scanning area (4), a lighting means (6), an optical system (7, 8) and an electrical/optical scanning means (9) giving an electrical signal (A) as a function of the fingerprint when the finger is moved in contact with the scanning surface (3) in the direction of the arrow. The scanning is undertaken by line scanning along the scanning line (4) in that the scanning line is imaged onto the active part of the scanning means (9). The active part consists for example of a number of substantially punctiform photodiodes (10) which are coupled in the electrical circuit and receives control signals (B) so that the photodiodes are scanned successively.

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1 METHOD AND APPARATUS FOR AUTOMATIC SCANNING OF
FINGERPRINTS.

5 The invention relates to a method of the kind described in the introduction to claim 1 and to an apparatus for carrying out same as described in the introduction to claim 6.

10 There are known various methods for optical scanning of the fingerprint side of a finger for ascertaining the identity of a person or for identifying the characteristic papillary pattern of a finger. The scanning may take place manually and the papillary
15 pattern may be characterised by means of one of the known systems whereof some are digital so that the pattern characteristics may be machine processed as soon as the characterisation has been completed. Manual scanning, however, is highly time-consuming
20 because a fingerprint readily comprises 25 characteristic details whereof at least 6-10 details will often have to be characterised in order to achieve positive identification.

25 There has therefore been developed various apparatuses for optical scanning of the fingerprint side of a finger. These apparatuses have a movable optical means which scans the fingerprint side. Mechanically movable means are difficult to design
30 so that they will not take up too much space and such apparatuses moreover require regular maintenance.

The object of the invention is to provide a method

- 1 and an apparatus for optical/electrical scanning
of the fingerprint side of a finger without using
any mechanically movable means so that there is
obtained an apparatus which will not require
5 maintenance. It is moreover an object to provide
an apparatus which is rather small so that it can
be built into existing apparatuses such as telephone
apparatus, entrance control apparatus and the like.
- 10 This object is achieved by proceeding as further
disclosed in the characterising part of claim 1,
for example by using an apparatus as further
disclosed in the characterising part of claim 6.
In stead of mechanically scanning the fingerprint
15 side, it is according to the invention the finger
which is moved during an optical/electrical scanning
where simultaneously with or immediately before
the scanning the rate of movement of the finger
is measured. The mechanical movements in the known
20 apparatuses have thereby been transferred into
a modest finger movement where in stead of placing
the finger on or in a scanning means, the finger
is slid on a scanning surface, whereby the
fingerprint side is scanned and there is obtained
25 an electrical signal representing the fingerprint
which signal can be processed in the usual manner
in electrical apparatuses for example for
comparaison with stored information.
- 30 By proceeding as disclosed in the characterising
part of claim 2, a simple way of performing the
scanning is achieved. It is sufficient to make
the scanning surface transparent at the place of
scanning. The points along the scanning line where

1 the finger touches the surface (the ridges of the
fingerprint) will reflect the light differently
from the points where the finger does not touch
the surface. By scanning the passing finger line
5 by line there is obtained a complete scanning of
the fingerprint.

By proceeding as disclosed in the characterising
part of claim 3 there is achieved increased
10 certainty of identification or recognition in that
the use of copied prints of fingers or the use
of a false finger such as a plastic or rubber cast
is thereby excluded. By proceeding as disclosed
in claim 3 it is simply checked whether it is a true
15 finger or not.

An improved scanning is obtained by proceeding
as disclosed in the characterising part of claim
4. There is moreover obtained increased safety
20 against undue entering or wrong identification.
By a uniform friction between the finger and the
scanning surface it is possible in a simple manner
electrically to synchronise or scale the line
scanning with the rate of movement which will be
25 sufficiently constant during the scanning. The
rate measuring is thus used for synchronising or
scaling the scanning.

By measuring the skin resistance as disclosed in
30 the characterising part of claim 5 there is obtained
a sufficiently accurate measuring to determine
whether it is a genuine finger or not.

The apparatus according to the invention may be

1 designed as disclosed in the characterising part
of claim 7. It is sufficient to make the scanning
area transparent by the scanning line. If, for
example, a scanning surface made of plastics, for
5 example glass or synthetic materials such as acrylic
plastics is used, the entire surface except the
scanning area itself may be coated by a black
coating such as black paint or the like so that
undesirable light or undesirable reflections are
10 avoided. There is thus obtained an apparatus that
is insensitive to changes in light strength etc.
in the surroundings where the apparatus has been
mounted.

15 The apparatus may practically be designed as
disclosed in the characterising part of claim 8.
There is thus obtained a simple apparatus where
the purely physical design may be changed in many
different ways, for example dependent on where
20 the apparatus is to be used or mounted.

The functioning of the apparatus and certainty
of correct measuring are further increased by
designing the apparatus as disclosed in the
25 characterising part of claim 9; this will not,
however, substantially increase the complexity
or power consumption of the apparatus.

30 The measuring means in the apparatus is according
to the invention preferably designed as disclosed
in the characterising part of claim 10. The result
is inter alia that the apparatus can be divided
in two parts, one part where the scanning is done,
and another part, the electrical part, from where

1 the scanning is monitored and controlled. The two
parts may without any practical problems be placed
apart.

5 It is obvious that a method and an apparatus
according to the invention may be used for many
different purposes, but has preferably been
developped for use in connection with entrance
control as further disclosed in claim 11.

10

The invention will be further explained in the
following with reference to the drawing showing
an embodiment of the invention wherein

15 Fig. 1 shows the scanning system itself,
and

Fig. 2 shows the electrical circuit therefor.

20 In the drawing reference numeral 1 is a finger,
the fingerprint side 2 of which is to be scanned.
The finger is moved in contact with a scanning
surface 3 on a part 16 of an apparatus which part
may for example be a moulded acrylic block or a
25 similar transparent material. In the scanning
surface 3 there is arranged a measuring means 5
for skin resistance and finger rate of movement
and there is moreover shown a scanning area 4 in
the form of a scanning line. The scanning surface
30 3 with the measuring means 5 is designed so as
to give all over the surface a substantially uniform
friction against the finger movement so that without
problems it is possible to move the finger at the
same constant rate across the measuring means 5

1 and the scanning line 4. The measuring means 5
consists for example of five mutually separated
measuring wires made of electrically conducting
material embedded in the surface. The centre wire
5 and the two outer wires are connected to each other
and are used as reference, for example frame
connected, whereas the two remaining wires C and
D are connected to the measuring circuit shown
in Fig. 2. The rate of the finger is measured by
10 registering the points of time T_C and T_D where
the finger 1 loses contact with the second and
the fourth wire, respectively, in the direction
of movement.

15 In the shown and explained example the measuring
means 5 has five measuring wires. It is obvious
that it is possible to use some other number of
measuring wires - the entire surface 3 may if so
desired be covered by measuring wires - dependent
20 on the measuring method etc.

Under the apparatus part 16 there is arranged an
elongate lighting means 6, for example an elongate
lamp, a dense row of light diodes or some other
25 form of elongate light source. The lighting means
6 is placed perpendicularly to the direction of
movement of the finger and is provided with a
reflector or a slit-shaped shutter so that
substantially all light is directed towards the
30 scanning area 4. The lighting means 6 may be mounted
next to the apparatus part 16 as shown in Fig.
1, but may also be mounted inside the apparatus
part 16, for example in a cylindrical cross bore.

1 Next to a light pass surface 11 there is provided
a mirror 7, for example a surface mirror throwing
reflected light from the entire scanning area 4
onto the active part 10 of an optical/electrical
5 scanning means 9 which part 10 is for example a
linear photoarray with for example 256 punctiform
photocells. The line 4 is imaged onto the linear
photoarray 10 by means of an optical system that
may comprise one or more lenses 8. The
10 optical/electrical means 9 receives control signals
through a wire B in such a manner that only one
photocell at a time will give an electrical signal
through the wire A representing the light intensity
by which the cell is influenced. Through wire A
15 there is thus obtained an electrical analog signal
representing reflected light from the line 4, i.e.
a line scanning of the contact print against the
scanning surface 3 of the print side 2 of the
finger.

20 The rate of movement of the finger 1 measured with
the measuring means 5 is used for synchronising
or scaling the scanning.

25 In order to avoid false reflections and to be
capable of using as weak a lighting means 6 as
possible, the entire apparatus part 16 has been
painted dull black, except on the scanning area
4 and on the light pass surface 11.

30 By adjusting the mirror 7 it is possible to move
the scanning area 4, for example in such a manner
that it is placed quite close to the rate measuring
means 5. If desired, the scanning line 4 may be

1 placed between two of the measuring wires, for
example between the two last wires in the direction
of movement of the finger.

5 Fig. 2 of the drawing shows a schematic block
diagram of the electrical circuit. At the left
top the scanning surface 3 with the measuring means
5 and the two measuring wires C and D are shown.
A 10 kHz square voltage may for example be applied
10 to the wires C and D so that noise and mains hum
problems are avoided. The wires C and D are
connected to each its bridge circuit and the finger
contact is detected when the bridge is brought
off balance when the finger touches the wire. The
15 points of time T_C and T_D are measured when the
finger leaves the respective wire and the time
difference is used as an expression of the rate
of movement of the finger. At the same time the
circuit 12 measures the skin resistance twice i.e.
20 between wires C and D and the other three connected
wires, respectively. The result of the measurement
of the skin impedance or the skin resistance and
the measured points of time T_C and T_D is directed
to a control and converter circuit 14 which also
25 contains the power supply to the various circuits
and the lighting means 6.

The scanning means 9 is via an amplifier 13
connected to the control and converter circuit
30 14 which inter alia by means of the impulses
received from a clock generator undertakes the
required controlling, signal processing and
digitalisation of the measurement results from
the photo array 10 and sends the digital measurement

1 results to a binary store 15 such as a 256 x 256
x 1 bit store which may exactly hold one complete
fingerprint. It is obvious to a person skilled
in the art that other sizes and forms of store
5 circuits may be used. From the store 15 the
digitalised fingerprint may be transmitted for
data processing together with any required
synchronisation signal.

10 The data processing itself of the stored fingerprint
does not form part of the invention and will
therefore not be further described.

It is obvious to a person skilled in the art that
15 the electrical circuit shown in Fig. 2 may be
designed and built up in a great number of different
ways and that the circuit may moreover be
constructed by using generally known circuits while
obtaining the desired function.

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PATENT CLAIMS

1. Method for automatic scanning of fingerprints by optical scanning of the fingerprint side of a finger, characterised in that the finger is moved along a scanning surface while measuring the rate of movement in relation to the scanning surface and in such a manner that by contact between finger and surface there is formed an optical papillary pattern corresponding to a fingerprint whereupon the pattern is scanned when passing a scanning area and is converted into an electrical signal.

2. Method according to claim 1, characterised in that the scanning surface is transparent in the scanning area and the passing papillary pattern is being scanned line by line perpendicularly to the direction of movement.

3. Method according to claim 1 or 2, characterised in that the skin resistance of the finger is measured substantially at the same time while measuring the rate of movement.

4. Method according to claim 3, characterised in that the entire scanning surface is designed so as to give substantially the same friction against the finger and that the skin resistance and the rate of movement are measured immediately before or simultaneously with the scanning of the fingerprint

1 and that there is formed no electrical signal
corresponding to the finger print if the skin
resistance and/or the rate of movement lie(s)
outside pre-determined ranges.

5

5. Method according to claim 3 or 4,
characterised in that the skin
resistance is measured by at least one impedance
measuring by using alternating current.

10

6. Apparatus for automatic scanning of fingerprints
according to claim 1 by optical scanning of the
fingerprint side of a finger,
characterised in comprising a scanning
15 surface (3) with a measuring means (5) for the
rate of movement of the finger in relation to the
scanning surface and with a scanning area (4)
incorporating a lighting means (6), an optical
system (7, 8) and an electrical/optical scanning
20 means (9) giving an electrical signal (A) as a
function of the fingerprint.

7. Apparatus according to claim 6,
characterised in that the scanning
25 surface (3) is transparent in the scanning area being
a rectilinear area (4) transverse to the direction
of movement of the finger and being adapted to
line by line scanning of the fingerprint as the
finger passes the area in that the scanning surface
30 is designed in such a manner that it has
substantially uniform surface friction on the entire
surface.

8. Apparatus according to claim 6 or 7,

1 c h a r a c t e r i s e d i n t h a t t h e l i g h t i n g
means (6) is an elongate light source provided,
if desired, with reflector or slit-shaped shutter,
that the optical system comprises focusing means
5 (8), and if desired, deflector means (7) so that
the scanning area (4) is imaged onto the active
part of the electrical/optical scanning means (9)
which part consists of an array of substantially
punctiform photodiodes (10) connected in an
10 electrical circuit which is supplied with control
signals (B) in such a manner that the photodiodes
are scanned successively.

9. Apparatus according to claim 6,
15 c h a r a c t e r i s e d i n t h a t t h e m e a s u r i n g
means (5) is furthermore provided with conductor
means (C, D) for measuring the skin resistance
of the fingerprint side (2).

20 10. Apparatus according to claim 6 or 9,
c h a r a c t e r i s e d i n t h a t t h e m e a s u r i n g
means (5) consists of a number of electrical
conductors placed apart and arranged transverse
to the direction of movement in the surface of
25 the scanning area (3) where between some of the
conductors there is applied an alternating voltage
for determining the impedance of the skin and a
voltage for determining the rate of movement of
the finger in that the points of time are scanned
30 when the finger loses electrical contact with the
conductors and the time difference is used for
determining the rate of movement.

11. Use of an apparatus according to any one of

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1 claims 6 to 10 for entrance control to premises
or for operating apparatus.

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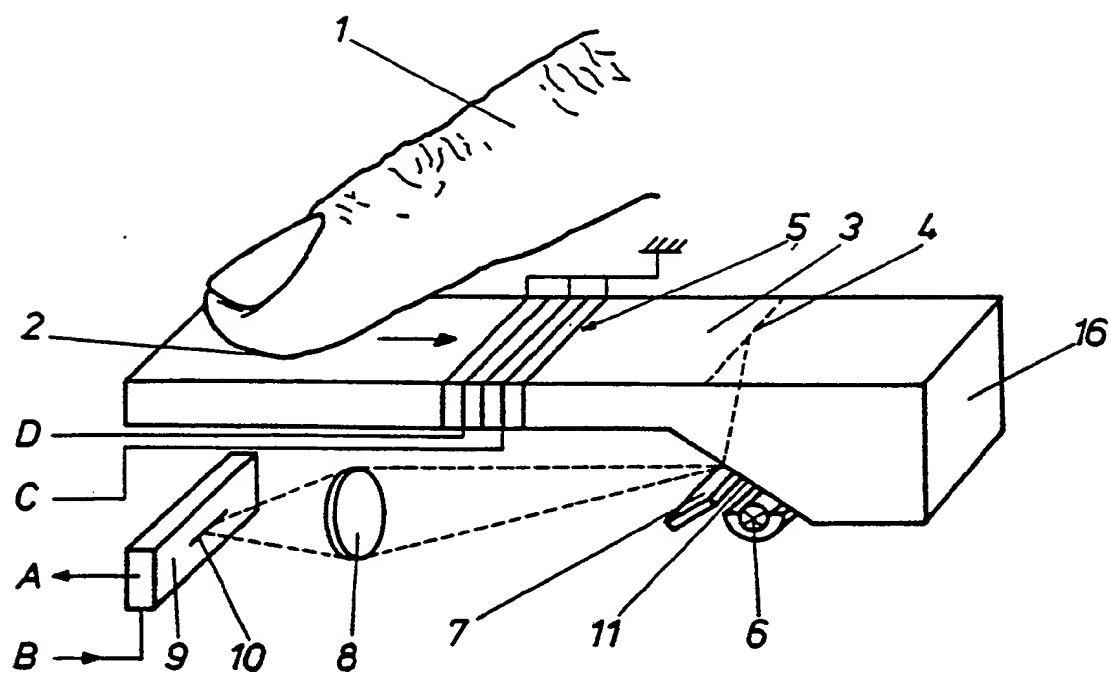


Fig. 1

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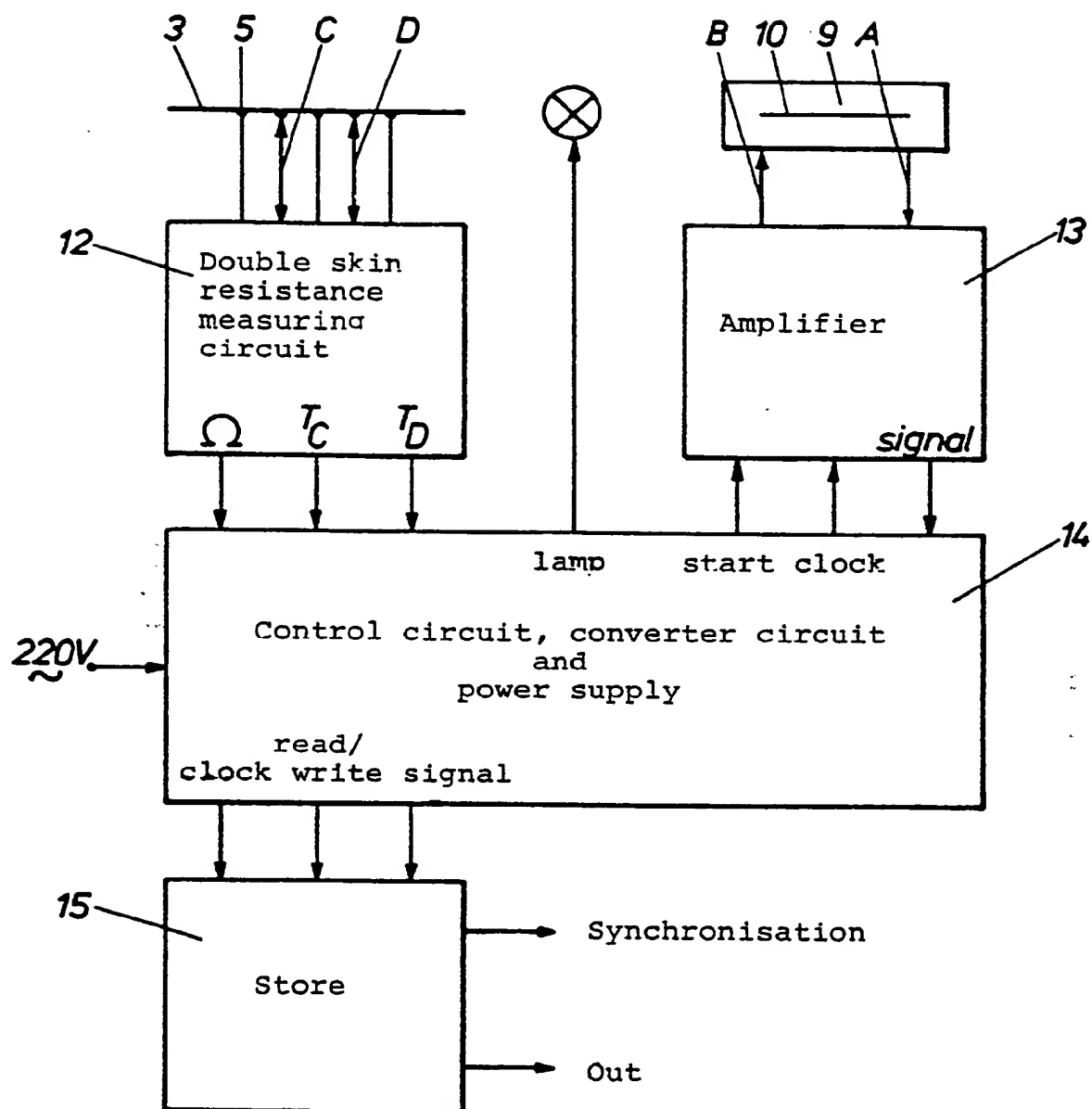


Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No **PCT/DK86/00044**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ¹		
According to International Patent Classification (IPC) or to both National Classification and IPC ⁴		
A 61 B 5/10		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC 4 US C1	A 61 B 5/05, /10; G 01 P 3/42, /64, /66 <u>118</u> :31.5; <u>356</u> :71; <u>427</u> :1	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	US, A, 4 322 163 (MICHAEL SCHILLER) 30 March 1982	1, 2, 6, 7, 8, 10
A	DE, A1, 2 056 472 (OMRON TATEISI ELECTRONICS CO.) 3 June 1971	3, 4, 5, 9, 10
A	EP, A1, 0 045 913 (SIEMENS AKTIENGESELLSCHAFT) 17 February 1982	8
A	SE, B, 321 110 (EBAUCHES SA) 23 February 1970	1, 3, 6, 10
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1986-07-30	31 JUL 1986 (31. 07. 86) ¹⁴	
International Searching Authority	Signature of Authorized Officer	
Swedish Patent Office	<i>Gunnar Hilderoth</i> Gunnar Hilderoth	

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FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This International search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

- 1) Claims 1, 2, 6, 7, 8, 10: Optical scanning of fingerprints.
- 2) Claims 3, 4, 5, 9, 10: Measurement of skin impedance.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☒ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

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